ROYAL ASTRONOMICAL SOCIETY.

Vol. XV. *April* 13, 1855. No. 6.

M. J. Johnson, Esq. President, in the Chair.

Rev. Wm. Selwyn, Ely, and
W. R. Vines, Esq., Ealing, Herts,
were balloted for and duly elected Fellows of the Society.

Discovery of a New Planet. By M. Chacornac.

Admiral Smyth has received a letter from M. Chacornac announcing his discovery of a new telescopic planet of the eleventh magnitude at the Imperial Observatory, Paris, on the 6th of April. The following positions of it were obtained by a comparison with the star 25438 in the Catalogue of Lalande:—

1855.	Paris M.T. h m s	Right Ascension. h m s	Declination. ° ′ ″
April 6	13 10 49·6		
	28 5·6	13 39 50·02	−7 28 7·8
	15 32 53·9		
	51 40·1	13 39 45·19	−7 27 24·2

This discovery was also announced in a printed circular issued by M. Le Verrier, Director of the Imperial Observatory.

Elements of Chacornac's Planet. By M. Lesser.

Epoch, 1855 April 20·45093 M.T. Berlin.

	°	′	″	
M	38	48	53·0	
π	157	51	19·7	Mean equinox,
Ω	184	1	45·3	1855·0
φ	6	34	5·0	
i	5	10	10·5	
log a	0·426961			
μ	2·909565			

These elements are calculated from the following observations:—

1855.	Berlin M.T. h m s	R.A. ° ′ ″	Decl. ° ′ ″	
April 6	14 44 14·0	204 57 5·3	−7 27 58·1	Paris
13	10 2 54·1	203 36 35·4	−6 38 57·2	Vienna & Berlin
20	10 49 20·7	202 12 53·3	−5 49 36·6	Berlin

Discovery of a New Planet. By M. Luther.

Mr. Hind has received a letter from M. Luther, announcing his discovery of a new planet of the eleventh magnitude on the 19th of April, at the Observatory of Bilk. The following are two of its positions as provisionally reduced:—

1855.	Bilk M.T. h m	R.A. ° ′	Decl. ° ′
April 19	13 30	181 14	−5 11
20	10 27	181 6	−5 11
	Daily motion	−9	0

Discovery of a New Comet (Comet II., 1855). By M. Schweizer.

On the 11th of April, about 11 o'clock in the evening, Dr. Schweizer, Astronomer, attached to the Geodesical Observatory of Constantine at Moscow, discovered a small telescopic comet, for which he obtained the following approximate positions by reference to Argelander's Star Charts:—

1855.	M.T.	Comet's R.A. ° ′	Comet's Decl. ° ′
April 11	11	184 40	−17 20
15	11	182 20	−13 40

Its daily motion is accordingly at present about,—

In R.A.	−35′ 0
In Decl.	+55 0

On the Method of Observing the Positions of Spots on the Sun, and of Deducing their Heliographical Longitude and Latitude, adopted at Redhill Observatory. By R. C. Carrington, Esq.

"No change has been made in the mode of observation described in No. 5 of vol. xiv. of the *Monthly Notices*, but an improvement of the process of reduction has been introduced, which it is the object of this second communication to explain.

"Referring generally to the former description, and as before denoting by the letters A_1, A_2, B_1, B_2, the instants of contact of the sun's limb with the wires A *a*, B *b*, and by the letters *a*, *b*, those of a spot,

let $$A = \tfrac{1}{2}(A_1 + A_2), \quad B = \tfrac{1}{2}(B_1 + B_2)$$

also let $$\tan \alpha_1 = \frac{B_2 - B_1}{A_2 - A_1}, \text{ and } \tan \alpha_2 = \frac{b - B}{a - A} \cdot \operatorname{cotan} \alpha_1,$$

then will $\alpha_1 + \alpha_2 + \iota$ be the angle of position of the spot on the disk from the north point reckoned towards the east, ι being the correction due to the inclination of the sun's path to a parallel of declination, and very nearly equal to four times the hourly increment of declination given in the *Nautical Almanac*, with its proper sign. If we denote the distance of the spot from the centre of the disk, expressed as a decimal of the radius, by $\frac{r}{R}$, we shall have

$$\frac{r}{R} = 2 \cdot \frac{b - B}{B_2 - B_1} \cdot \operatorname{cosec} \alpha_2, \text{ or } = 2 \cdot \frac{a - A}{A_2 - A_1} \cdot \sec \alpha_2$$

the first or the second expression of the two being used, accordingly as $b - B$ is greater or less than $a - A$.

"Let (R) be the sun's tabular semidiameter expressed in minutes of arc, and let $\varrho' = \frac{r}{R} \cdot (R)$, then will ϱ, the angular distance of the spot on the sun's body from its apparent centre, be found from the expression $\varrho = \sin^{-1} \cdot \frac{r}{R} - \varrho'$, the angle $\varrho + \varrho'$ being taken out to minutes and tenths.

"The quantities $\alpha_1 + \alpha_2 + \iota$ and $\frac{r}{R}$ give the means of forming a diagram of the appearance of the disk.

"*Second Step.*—Let the inclination of the sun's equator to the ecliptic be denoted by I, and the longitude of its ascending node by N. (The provisional values used at Redhill for 1854·0 are $I = 7^\circ\ 10'$, and $N = 74^\circ\ 30'$.) It is convenient to tabulate, for every degree of argument, the angles

$$\beta = \tan^{-1} (\cos \odot \cdot \tan \omega), \qquad \gamma = \tan^{-1} (\cos \overline{\odot - N} \cdot \tan I),$$

$$\alpha = \tan^{-1} (\tan \overline{\odot - N} \cdot \cos I), \quad \delta = \cos^{-1} (\sin \overline{\odot - N} \cdot \sin I),$$

where α and δ are respectively the heliographical longitude and north polar distance of the earth.

Let

$$\chi = \overline{\alpha_1 + \alpha_2 + \iota} + \overline{\beta + \gamma}$$
$$\cos \phi = \cos \varrho \cdot \cos \delta + \cos \chi \cdot \sin \varrho \cdot \sin \delta,$$
$$\sin \theta = \sin \chi \cdot \sin \varrho \cdot \operatorname{cosec} \phi$$

then will $\overline{\alpha - \theta}$ and ϕ be the heliographical longitude and north polar distance of the spot.

"It will be remarked that no account is here taken of the effect of refraction. The reason is, that a little experience convinced me that, unless its effect could be allowed for in current reductions in some very simple manner, it was better to omit it; and I have not been able to devise any mode of computing a correction for it at all corresponding in brevity to the above formulæ.

"The brevity of the formulæ now given will best be shown by an example, and for this purpose we will take an observation of the principal nucleus of the large spot seen in January last.

"The mean of three passages on Jan. 18th gave the following numbers:—

A_1	h m s 19 36 28·867	Slow 55s·5	Longitude 41s·3 W.
B_1	36 43·867	G.M.T. of obs.	1855, Jan. 17d 23h 51m.
a	37 40·133	$\odot$ = 297° 53′·7	β = +11° 28′·8
b	38 5·067	N = 74 30·7	γ = − 5 13·2
A_2	39 48·067	$\odot$ − N = 223 23·0	ι = + 2·1
B_2	19 39 59·800	α = 43 9·5	δ = 94 55·0

$B_2 - B_1$ = 195·933	Log = 2·29211	Log tan α_1 = 9·99282
$A_2 - A_1$ = 199·200	Log = 2·29929	α_1 = 44° 31′·6

$b - B$	= − 16·767	Log $(b - B)$	= −1·22445
$a - A$	= − 28·334	Log $(a - A)$	= −1·45231
Log $(a - A)$	= 1·45231	Diff.	= +9·77214
Log $(A_2 - A_1)$	= 2·29929	Log tan α_1	= 9·99282
Diff.	= 9·15302	Log tan a_2	= +9·77932
Log sec α_2	= 0·06708	α_2	= 211° 1′·9
Log 2	= 0·30103	α_1	= 44 31·6
Log $\frac{r}{R}$	= 9·52113	ι	= + 2·1
Log (R)	= 1·212	$\beta + \gamma$	= + 6 15·6
Log ϱ'	= 0·733	χ	= 261 51·2
Log cos ϱ	= 9·97488	$\varrho + \varrho'$	= 19 23·4
Log cos δ	= −8·93301	ϱ'	= 5·4
Log n_1	= −8·90789	ϱ	= 19 18·0
Log cos χ	= −9·15140	Log sin χ	= −9·99559
Log sin ϱ	= 9·51919	Log sin ϱ	= 9·51919
Log sin δ	= 9·99840	Log cosec ϕ	= 0·00357
Log n_2	= −8·66899	Log sin θ	= −9·51835
n_1	= −0·08089	θ	= −19° 15′·6
n_2	= −0·04667	α	= 43 9·5
$n_1 + n_2$	= −0·12756	$\alpha - \theta$	= 62 25
Log $(n_1 + n_2)$	= −9·10571	ϕ	= 97 20

"The result of the calculation is accordingly,—

Angle of position, 255° 35′·6	Dist. from centre, 0·3320
Heliographical long. 62° 25′	Latitude, 7° 20′ South

"As was mentioned in the Annual Report lately published, this process of reduction has been applied at Redhill to all the observations of spots which were obtained during the past year, and a tolerably continuous catalogue of positions and of corresponding diagrams is consequently accumulating. As I feel well satisfied after a full trial with the method now put forth, and think it improbable that a shorter one can be devised, I

venture again to express a hope that those who interest themselves in this subject will give my method a trial.

"The following series of observations of a small spot may be useful as exhibiting the degree of accuracy of the results obtained:—

1854.	G.M.T. h m	Pos. ° ′	Dist.	H. Long. ° ′	H. Lat. ° ′
Aug. 25	0 12	123 2	·9399	189 24	S. 10 14
26	0 51	126 44	·8445	203 23	10 20
27	1 32	132 9	·7022	218 10	10 3
28	0 41	141 24	·5481	231 56	10 13
29	0 38	159 58	·3912	246 19	10 23
30	0 32	195 9	·3031	260 29	10 23
31	1 6	235 23	·3611	275 6	10 19
Sept. 1	0 24	256 34	·5033	288 54	10 8
4	The spot had entirely disappeared.				

"Such series, it is needless to state, are suitable for a basis for the further correction of the assumed elements of the position of the sun's poles. I have, of course, several such series already observed, but they are not yet sufficiently numerous to warrant the adoption of any certain corrections of the assumed values of I and N. The problem of correcting the assumed position of the sun's axis from such data is similar to the case of finding the error of position of the polar axis of an equatoreal from three or more observations in north polar distance of the same star at different hour-angles.

"My observations during 1854 suggest one or two remarks which may be appended here, although they are, I hope, by no means all that they will ultimately afford.

"1. The year 1854 has been one in which the number of outbreaks has been very few,—indeed, approaching a minimum. Now the reduced list of positions includes no spot more distant from the equator than 19° 30′ to the north, and 17° 0′ to the south. This circumstance appears to afford grounds for concluding that when the eruptive forces are comparatively quiet, the limits of parallel are also much contracted.

"2. On the 29th of September I observed a moderate-sized spot in position 110° 17′ from the north point, distance from centre = 0·9323, the penumbra of which included two detached nuclei; on the following day, the 30th, it was observed that the 'following' nucleus was outside the penumbra. Careful diagrams were made at the time on both days. I cannot reconcile this observation with the commonly received idea of the relation of nucleus and penumbra. As an isolated instance, it does not appear to call for more than being recorded at present; or rather I may say that, until other instances shall be met with, it appears to me to be premature to state the inferences which the observation seems to suggest.

"3. Throughout the year 1854 there has been a continual

tendency to recurrence of spots on the same parallels of latitude, both of individual spots on almost precisely the same parallel, and of groups within the same general limits. The parallels 71° to 75° Heliog. N.P.D. have been but rarely visited; the parallels 77° to 85°, frequently; from 86° 30′ to 89° 30′, not at all; from 90° to 92°, very rarely; from 92° to 94°, not at all; from 95° to 103°, frequently; from 103° to 107°, very rarely. In connexion with this circumstance, I would suggest whether it be not worth while to examine into the possibility of an explanation arising from the hypothetical revolution of an inner body, on which may be situated the volcanic centres of eruption, in a shorter period than the revolution of the envelope on which we see the effects in the form of ruptures of continuity. It will appear to any one who considers this suggestion that, to bring it to the test of facts, there will be required a collection of observed positions of nuclei on the same parallel, together with the times of their first appearance on the envelope; and accordingly, I would recommend fellow-labourers on this subject to be careful to record the occurrence of outbreaks which they may succeed in ascertaining to have taken place between two consecutive days."

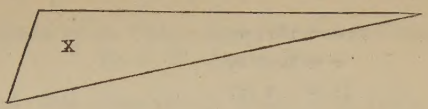
Remarks on the Orbits of α Centauri and σ Coronæ Borealis.
By Capt. W. S. Jacob, Astronomer at Madras.

In the *Monthly Notices* for January are given the elements of two orbits for *α Centauri*, contributed by Messrs. E. B. Powell and J. R. Hind. The latter, probably, represents the observations pretty fairly, but the former can scarcely be said to do so, as it makes the observed distances before 1846 all too great, and after that epoch all too small, while even in the angles there is in a general way the same opposition of signs, though not quite without exception; in such a case, it is evident that the sum of the errors or of their squares must be capable of considerable reduction.

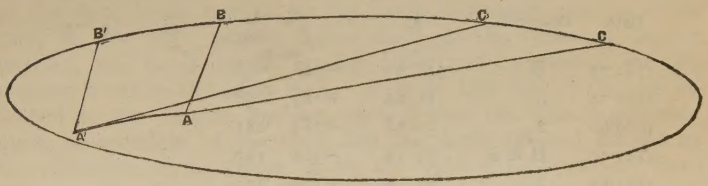
"But, in fact, the agreement of the orbit with observation is no proof that it is even an approximation to the true one: where we have given only a small portion of the periphery of an ellipse, it is evident that with a very slight change of curvature we may adapt it to many different ellipses; and, even when we are pretty sure of the dimensions of the apparent ellipse, it may happen that a very slight change of position of the projected focus may cause a great variation in the true elements. This is the case in the present instance: I have computed a number of orbits for this star, but for some years have given up the attempt, as the data are insufficient; though we can lay down the apparent orbit very closely, we cannot as yet get even a decent approximation to the true one.

"The reason is this: La Caille's observations in 1751, though not, of course, minutely accurate, enable us to fix the periodic time within a small quantity; since the stars had returned to the same

relative position about 1830, the period must evidently be about 79 years, within a year or two either way; and as we know pretty exactly the area now described annually by the radius vector, we can also fix nearly the total area of the apparent ellipse. The path described from 1834 to 1854, the only time within which trustworthy observations are available, is shown on the slip marked X, and is of such extent and small curvature that it must



include the extremity of the minor axis, and having given the curvature at this point and the area, the dimensions of the ellipse are fixed. It appears that the axes must be about 28″·80 and 6″·86, as shown in the lower diagram. If we now try to fit the slip X to the periphery of the ellipse, we find it may take the position A B C; but, by reason of the slight change of curvature



in so elongated an ellipse for a considerable distance on either side of the minor axis, it may also be *slided* round the curve as far as A′B′C′ without material error, the locus of the principal star, or projected focus, being the thick line A A′, and, with the exception of not being *very* likely to fall quite close to either extremity, it may as well occupy one part of the line as another, and the observations will be equally well represented whatever point be fixed on. This, then, allows a range in per. pass. of from 1858·5 to 1867·8, and in *e* from ·54 to ·96; while *a* may range from 15″ to 31″. These limits may be a little further extended by slight variations in the dimensions of the apparent ellipse, but they will be somewhat narrowed by the end of the current year; for if the first position be nearly true, the places at 1856·0 will be 309°·0 and 3″·75, and if the second, 312°·6 and 3″·45,—a difference which observation would be sure to detect; still we shall not be able to get a good approximation until the extremity of the ellipse has been reached, or nearly so.

"*σ Coronæ Borealis.*

"In the same Number (page 90) is given, also by Mr. Powell, an orbit for *σ Coronæ Borealis*, which appears from the comparisons cited to agree closely with observation. There are, however, a few epochs omitted where the agreement would not be

quite so close; it may also be doubted whether the plan of grouping together several epochs into one is quite legitimate, for in the case of such quick-moving stars the mean of angles extending over two years would not correspond to the mean of the times.

"The following elements will be found to represent the observations pretty fairly, but they will admit of considerable variation:—

$\tau = 1831{\cdot}17$
$\varpi = 107^\circ\ 13'$
$\Omega = 1\ 57$
$\lambda = 101\ 57$
$\gamma = 46\ 47 \quad \cos = [9{\cdot}83552]$
$e = {\cdot}3088$
$P = 195^{yr}{\cdot}12 \quad n = 1^\circ{\cdot}845$
$a = 2''{\cdot}717$

Comparison.

Date.	Observer.	θ_o	$\theta_c - \theta_o$ ∠	arc.	ϱ_o	$\varrho_c - \varrho_o$
		° ′	′	″	″	″
1781·79	H	347 32	− 46	·038		
1802·74	,,	11 24	+ 85	·058		
1819·60	Σ	50 18	+183	·081		
1821·30	H & S	65 15	−302	·129		
1822·67	Σ	61 0	+300	·123		
1823·47	H & S	72 56	−199	·082	1·45	−·055
1825·44	S	77 31	+104	·040	1·48	−·160
1826·77	Σ	89 0	−171	·065	1·30	+·012
1828·50	H	92 6	+183	·069		
1830·28	H	105 5	− 36	·014	1·22	+·092
1830·52	D	107 17	− 93	·035		
1830·76	Sm	107 36	− 37	·014	1·30	+·014
1831·34	D	111 32	− 93	·035	1·57	−·250
1831·36	H	108 46	+ 79	·030	1·39	−·070
1832·37	Sm	114 54	+ 21	·008	1·40	−·054
1832·55	D	115 57	+ 13	·005		
1833·36	,,	120 37	− 43	·017	1·30	+·084
1833·58	Sm	120 42	+ 14	·006	1·20	+·190
1835·50	,,	130 54	− 86	·033	1·40	+·048
1839·67	,,	145 6	− 6	·003	1·60	+·064
1843·35	,,	155 54	− 2	·001	1·80	+·015
1846·21	*j*	161 58	+ 49	·027	2·25	−·300*
1853·14	,,	177 54	− 54	·034	2·18	+·040
1853·35	Powell	175 12	+130	·083		
1854·05	*j*	177 52	+ 45	·029	2·22	+·036

* Only a single night's measure, and not very good.

"N.B. As it is desirable that the same observer should be always designated by the same letter, and as J has been already appropriated by Manuel Johnson, it will be better to keep to *j* for designating my observations."

5 *March*, 1855.

Description of an Observatory erected at Grantham.
By J. W. Jeans, Esq.

"I erected this observatory about five years since. The transit-room is placed between the two roofs; the timbers which carry the floor-joists being firmly spiked to the rafters of the roofs, abutting against their tye-beams; the pedestal of the transit is quite free from the floor; the walls are of wooden frame-work covered with sheet-iron, canvassed and papered inside; the roof ditto ditto, but having felt under the iron, which is galvanised. The equatoreal-room is constructed in a similar manner; the joists of the floor being carried by the outer or western purling of the roof, at one end, passing quite clear of the inner or eastern purling, and being carried at the other end by timber uprights passing down to the party wall. A large box full of sand is attached to the eastern purling, upon which the equatoreal rests, quite independent of the floor, and but little affected, except by the vibration of the house itself; the walls of this part are lined with boards; the roof consists of light wood framing, covered with felt and sheet iron; it has double shutters, about 22 inches wide, opening quite across from curb to curb, in four sections closed at top by a square shutter, which can be raised so as to allow observations quite in the zenith. The curb is made of American oak, top and bottom double, lined with one-eight inch sheet-iron, and running on cast-iron balls. I cannot state the cost of erection, as it was partly constructed of old materials, and I did a great deal of the work (nearly the whole of the dome) myself.

"The transit is by Cary, 2 ft. long, 2 in. aperture, 6 in. circle, divided to 30′, reads to 1″; striding level; it is very steady to its adjustments, and performs very well. The equatoreal also by Cary, $3\frac{7}{8}$ in. aperture, 5 ft. 9 in. solar focus, circles 9 in. diameter, H. C. divided to 1^m reads to 2^s, D. C. divided to 15′ reads to 30″; it performs very fairly. The clock-work to it is of mine own adaptation. The clock is an old one, Grantham make, dead beat, and furnished with a wooden compensating pendulum-rod, of mine own construction; its rate is very steady and good. My position, according to mine own observation, is

Lat. 52° 24′ 52″ North
Long. 0 39 0 West.

[The foregoing description was accompanied by a complete and very neatly executed drawing of Mr. Jeans's observatory.—Editor.]

On the Theory of M. Foucault's Gyroscope Experiments.

By the Rev. Baden Powell, M.A. F.R.S., &c.

The remarkable experiments of M. Foucault for exhibiting both a new direct proof of the earth's rotation, and the indirect effect of it in the "orientation" of the axis of a disk influenced only by mechanical rotation, have excited great interest; and thus an attempt to elucidate and simplify the *theory* of them may not be regarded as useless, especially as that *theory* has been found in some degree obscure and complex, more particularly as treated on the principle of M. Poinsot's theory of "couples." See *Comptes Rendus*, tom. xxxv.

The apparatus (or "gyroscope") consists essentially of a circular metallic disk, heavily loaded round its circumference, rotating on an axis, whose ends turn with the most perfect freedom in the opposite points of a brass circle, itself supported at the intervening opposite points on pivots in a second brass circle, suspended in a vertical plane by a thread without torsion at the top, and resting on a pivot at the bottom, both attached to an outer vertical frame. The motion of either of these circles can be suppressed, so that the axis of the disk can move either in altitude or in azimuth only, or freely in both (see fig. 1).

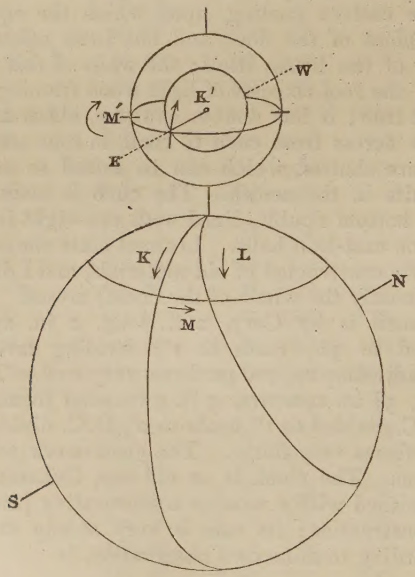


Fig. 1.

In these experiments the most material mechanical condition is what M. Foucault terms "the constancy of the plane of rotation,"—that is, the loaded disk having an immense rotatory

velocity communicated to it by the action of a train of wheels before it is placed on its pivots, retains, by virtue of its great acquired momentum, this motion *in the plane in which it was communicated*, independently of gravitation or any other circumstances,—so much so, as to resist with considerable force any attempt to place it in a different position.

In the following brief explanation it may be necessary to premise,—

1. The principle of the composition of rotatory motions, or that if a body be rotating about a given axis, and a tendency to rotate about another axis at the same time be given to it, the two rotations compounded will give a resultant rotation about a new axis inclined in a direction between the two former, whose position is determined by the well-known theorem, for which see Mr. Airy's tract on Precession.

2. The inverse principle of the resolution of rotatory motion, as applied by Euler to the rotation of the earth at any point on its surface, where the whole rotation being in a plane passing through the parallel of latitude of the place (which, for brevity, I call "the plane of latitude"), and the rotation for a given time (L) in that plane, it is resolved into two components, one in a circle passing through the place perpendicular to the meridian (K), the other in a circle (M) cutting the last at right angles, and whose centre is the place of observation. It is easily seen that the component (K) is *initially* proportional to the *cosine*, and (M) to the *sine* of the latitude (see fig. 1).

3. In any composition of forces p and q, of which r is the resultant, if the same action be repeated with p and r as components, the new resultant r_1 will lie between p and r. If it be again repeated r_2 will lie between p and r_1, and so on, till ultimately r_∞ will coincide with p.

Case I.—The disk rotates, being in perfect equilibrium, and free to move both in altitude and azimuth (see fig. 1).

Let us suppose the disk to have its axis in the first instance horizontal, and pointing east and west.

Then the rotation of the earth carries it along with the apparatus, and, if at rest, would cause it to incline towards the east in the plane of the latitude.

But, owing to "the constancy of the plane of rotation" the disk tends to retain parallelism to its original plane; and being perfectly free to move with respect to the apparatus, and wholly free from the influence of gravitation, it has a relative apparent motion equal and opposite to that of the earth in the plane of the latitude (L), the components of which in altitude (K′) and in azimuth (M′) are exhibited by the moveable circles of the apparatus respectively.

The motion in altitude would be inconvenient to observe, as it changes its plane continually; that in azimuth is easily observed, by means of a horizontal microscope with focal wires, directed to a small graduated scale on the edge of the vertical circle.

These motions continue with the rotation of the earth as long as the rotation of the disk is kept up: and the *rate* of the azimuthal motion is easily seen to be proportional to the *sine of the latitude* of the place, as in the case of the free pendulum.

Case II.—The disk rotates, having its axis horizontal, and free to move only in azimuth.

Let the plane of the disk (d) be at first parallel to the meridian (see fig. 2), or have its axis pointed E. and W.

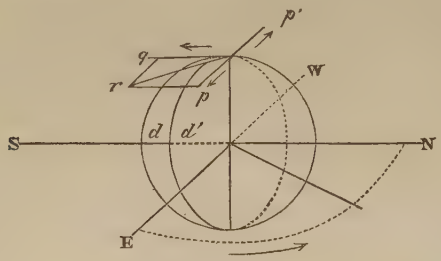


Fig. 2.

Then the constancy of the plane of rotation opposing the effect of the earth's rotation in the plane of the latitude tends to make the disk incline in that plane from east to west, initially in the direction (p') of the tangent to the arc which its upper extremity would describe. But the vertical diameter of the disk being fixed by the apparatus relatively to the earth, offers an equal and opposite reaction (p).

This has to be compounded with the rotatory motion of the disk (q), (suppose towards the south, at the upper part), which will give a resultant rotation (r) in a plane between the two; or the disk will take a new position (d'), to which (r) is a tangent, in a plane inclined to that of the meridian, its axis turning in azimuth from east towards north.

In this new position the same action will be repeated, the components being now (p) and (r), and the new resultant (r_1) will place the axis between the former position and the north, and so on, till it ultimately points to the north, coinciding with the meridian, in which position it will continue.

If the rotation had been the opposite way it is easily seen; a similar construction would give the disk turning from north towards east. And in either case, when in the final position, the rotation will be in the same direction as that of the earth.

Case III.—The disk rotates, having its axis free to move *only* in altitude, and in the plane of the meridian.

In the first instance, suppose the axis horizontal, and the rotation towards the east at the upper part (see fig. 3).

The disk, if free, would have an apparent motion opposite to that of the earth, or the eastern extremity of its horizontal diameter

would have a motion upwards in the plane of the latitude, whose initial direction (p') is the tangent of the arc it would describe.

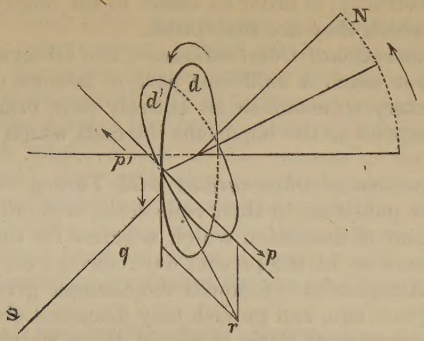


Fig. 3.

But this motion is counteracted by the apparatus giving an equal and opposite reaction downwards (p). This, combined with the rotation (q), gives a resultant (r) between them, in consequence of which the disk (d) takes a new inclination (d'), its axis ascending at the north end, till ultimately it becomes parallel to the axis of the earth, when the rotation of the disk will be in the same direction as that of the earth. If it had been originally rotating in the opposite direction, it is easily seen in the same way that it would come round to the same position.

Report of the Director of the Imperial Observatory of Paris on a Plan for Improving the Organisation of that Establishment.

In accordance with a decree of the Government, the Director of the Imperial Observatory of Paris has recently drawn up a Report on a proposed plan of operations to be pursued at that establishment with the view of placing it on a level with the other Observatories of the first class in Europe. The details of the plan are embodied in a Report recently addressed to the Emperor by M. Fortoul, Secretary of State for the Department of Public Instruction. The contents of this Report, of which the following is the substance, are classed under seven distinct heads.

1. *Meridian Observations.* — Operations of this kind were long imperfectly attended to in France. The first transit instrument was erected at the Paris Observatory only in the year 1800. Since that time foreign establishments have accomplished from year to year considerable progress. In order that the Observatory of Paris may maintain itself on a level with them, it is indispensable that an improvement be effected in the instruments available for that purpose, as well in regard to optical power as in

regard to stability. It will be necessary, besides, to construct a large meridian circle, and to economise the resources presented by dynamical electricity, in order to assure to the observations all the precision of which they are susceptible.

2. *Extrameridional Observations.*— The Observatory of Paris not having yet taken a sufficient part in labours of this kind, it will be necessary to establish an entirely new branch of service, in order to respond to the important interests which are dependent on them.

3. *Comparison of Observations with Theory.*— Observations were formerly published in their rude state, without appending to them the labour of discussion which acquires for them a scientific value. It is not so in the present day: foreign establishments in Europe and America have followed the example given by England twenty-five years ago, and publish only discussed observations.

The Observatory of Paris is one of those which have not yet adopted this improvement. It will be the more difficult to realise it in practice, inasmuch as the ephemerides which have served as the basis of reduction are still in an imperfect state. A plan in reference to this object, based upon eminently scientific principles, is stated to have been proposed by the Director of the Imperial Observatory.

4. *Relations with the Public Service.*— It is extremely desirable that the Observatory of Paris, after having made due provision for the advancement of science, should so dispose its resources as to enable the Government to profit by them. The study of the chronometers of the Imperial Marine might thus be improved, and the same advantage might be accorded to the Mercantile Marine. The different astronomical and meteorological instruments used at sea might also be compared at the Observatory.

The exact time might be sent daily by telegraph to the different parts of the empire, where it is to be obtained at present only imperfectly and for money. On extraordinary occasions it might be desirable to transmit to them atmospheric instructions, which might be necessary for the security of the shipping.

In order to determine with greater accuracy the principal data upon which the map of France has been constructed, it is suggested to unite the resources of the Observatory with those of the Ministry of War. It would be also desirable to transmit the exact time to the principal points of the Metropolis, &c. &c.

5. *Operations connected with Physical Science.*—The progress of astronomy is intimately allied to that of physics, and the latter tends to approximate towards astronomy as well by the services which it renders as those which it receives by borrowing its instruments and methods.

The establishment at the Observatory of a department of physical observations placed under the direction of a *savant* specially appointed for that purpose, is indispensable in the present day, not less for the wants of astronomy than for the solution of the great questions of modern physics. Such an establishment would

be extremely desirable for maintaining the optical instruments in a high state of efficiency, and for assisting artists in the fabrication of large glasses.

The use of telegraphic apparatuses, the employment of electricity in daily observations, as well as the relations of the observatory with the public service, necessarily demand the attention of a person well acquainted with experimental science.

It would also devolve on the physicist to investigate the advantages which might accrue to the sciences of astronomy and meteorology from the application of photography. Thus the photographic and instantaneous observation of the solar disk, by rendering available a source of light, the extreme intensity of which has hitherto been an object of dread, would assuredly furnish precious materials respecting the physical constitution of the sun.

The vertical has hitherto been considered as fixed, and yet theory indicates that gravity undergoes small variations both in intensity and direction under the influence of the combined attractions of the sun and moon. The investigation of apparatuses capable of indicating this kind of influence, and thereby furnishing new determinations of the masses of the sun and moon, would form an admirable subject of study to the physicist.

Finally, the velocity of light and of electricity has been established in the present day upon the surface of the earth. The same is true in respect to the rotation of the earth, a phenomenon of which the demonstration lately belonged exclusively to astronomy, but is now accessible to physics, which has furnished a proof of its existence that is sensible to all eyes. Still it may be affirmed that the labours undertaken with respect to this object, notwithstanding the just interest which they have excited, are yet only commenced. They might be resumed at the Observatory, receive there the last degree of precision, and thus be made to furnish important data for a knowledge of the solar system. This section concludes with recommending M. Leon Foucault to the office of Physicist to the Observatory.

6. *Meteorological Operations.*— It is also to the Physicist of the Observatory that the direction of the meteorological operations would belong, and this is not the least important part of the labours intrusted to him.

The establishment of model instruments, and of self-operating instruments; researches on the temperature of the air; on hygrometry, on pluviometry, on winds, on atmospheric electricity, on terrestrial magnetism, on atmospheric phenomena, such as halos, auroræ boreales, &c.: all this branch of meteorological observations is still to be created at the Observatory of Paris.

Even although confined to a single station, these studies would be of great utility. They would offer still greater interest if it were possible to extend them over the whole surface of the earth, and to trace across continents and seas the propagation of great atmospheric waves. It would be necessary for this purpose to

collect together the materials established at a great number of stations, and to institute a comparison between them. The electric telegraph promises in the present day to accomplish this important work with the most complete success.

7. *Scientific Administration.*—This section includes theoretical instruction, and also practical instruction in the art of observation, the care of publications and the charge of a vast and growing correspondence. In order to assure the improvement of these different departments it would be desirable to increase the salaries of the officials of the Observatory who are not remunerated in proportion to the difficulty and importance of their labours.

By an Imperial decree subsequently issued, the situation of Physicist of the Observatory has been instituted, and M. Leon Foucault has been appointed to this new office. The salaries of the astronomers connected with the Observatory have also been increased in pursuance of the same decree.

ERRATUM.

Page 161, line 3 from bottom, *for* agreement, *read* argument.

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